MIXED INTERFACE-TRACKING/INTERFACE-CAPTURING TECHNIQUE (MITICT) – IMPLEMENTATION FOR FLUID–OBJECT INTERACTIONS WITH TWO FLUIDS

M. Ungor[a], **J.E. Akin**[a] and **T. Tezduyar**[a]

[a]Team for Advanced Flow Simulation and Modeling (TAFSM)
Mechanical Engineering, Rice University – MS 321
6100 Main Street, Houston, TX 77005
ungormeh@rice.edu, akin@rice.edu, tezduyar@rice.edu

Two-fluid flows continue to be a significant challenge for computational fluid scientists. The main computational methods that are used in computing the interface between two fluids are the interface-tracking and interface-capturing techniques. Interface-tracking techniques, where the nodes of the mesh move to track the interface, usually yield more accurate results than interface-capturing techniques. However, successful implementation of interface-tracking techniques for complex and unsteady 3D flows may require frequent remeshing. As an alternative, interface-capturing techniques with enhanced accuracy can be used to compute complex two-fluid flows. When one investigates the technologically demanding fields like oil recovery, manufacturing, and geophysics, where two-fluid flows are of major concern, one can see that many of the applications also include moving solid–liquid systems. There is a definite need for accurate and computationally feasible flow solvers that can handle moving solid–liquid and fluid–fluid interfaces in complex flows. Mixed Interface-Tracking/Interface-Capturing Technique (MITICT) was introduced in [1], primarily for fluid–object interactions with multiple fluids. In the 3D implementation presented here the interface-tracking technique is the DSD/SST [2] formulation. The interface-capturing technique is the Edge-Tracked Interface Locator Technique (ETILT) [1].

ETILT was introduced to have better mass conservation and a sharper and more accurate representation of the interface than a standard interface-capturing technique. Similar to other interface-capturing techniques, ETILT determines and follows the interface location with an interface function governed by a time-dependent advection equation. In this presentation, the mathematical basis for the edge representation as well as projection from node level to edge level and vice versa will be discussed in detail. The flow field is computed by solving, in an iteratively coupled manner, the Navier–Stokes equations of incompressible flows and the time-dependent advection equation. While solid–fluid interfaces are tracked accurately with the DSD/SST formulation, fluid–fluid interfaces are captured with the ETILT. As a test problem, we compute a step-mold filling problem. The results are compared to results obtained using other interface-capturing techniques [3].

References

[1] T. Tezduyar, "Finite element methods for flow problems with moving boundaries and interfaces", *Archives of Computational Methods in Engineering*, v. 8, p. 83-130, 2001.

[2] T. Tezduyar, "Stabilized Finite Element Formulations for Incompressible Flow Computations", *Advances in Applied Mechanics*, v. 28, p. 1-44, 1991.

[3] M. Cruchaga, D. Celentano and T. Tezduyar, "Computation of moving interface problems with the Edge-Tracked Interface Locator Technique", *Proceedings of the Fifth World Congress in Computational Mechanics*, Vienna, Austria, 2002.